

Claims

What is claimed is:

1. An integrated voltage converter electronic circuit, comprising:

A plurality of integrated semiconductor and other electronic devices;

A first switch device connecting to an input power node at one of its channel terminals and to a first integrated inductor at the other, with the first inductor's second terminal connecting to an output node, where this series combination of the first switch and the first inductor is a portion of an integrated voltage down-converter;

A bypass circuit path, formed by a second switch device, or a series combination of a second switch device equivalent to the first switch device and a second inductor of the same self-inductance value as the first inductor, where the bypass circuit path connects between the input power node and the output power node of the integrated circuit in an electrically parallel configuration with the series combination of the first switch and the first inductor;

Voltage conversion circuits and conversion-bypass control circuits, receiving a plurality of signals as input, and connecting to the power input and output nodes of the integrated circuit as well as the control inputs of the first and second switch devices;

And a common semiconductor substrate upon which the first switch device, the second switch device, necessary voltage conversion and control circuits, the first inductor, and the second inductor are fabricated.

2. The apparatus of claim 1 where the switch devices are transistors fabricated in the semiconductor process employed to fabricate the common semiconductor substrate.
3. The apparatus of claim 1 where the switch devices are NMOS-FET (NFET) transistors, and further, where the turn-on control voltages provided to their control gate nodes may be higher than the input power node voltage and the turn-off control voltages may be higher than the output node voltage.
4. The apparatus of claim 1 where the inductors are fabricated using interconnect elements of high electrical conductivity embedded within a material of high magnetic permeability and high electrical resistivity upon the common semiconductor substrate.
5. The apparatus of claim 1 where the inductors share the same core magnetic flux path, thereby maximizing their consequent mutual inductance.
6. The apparatus of claim 1 where the electric current flow in the bypass pathway through the second inductor is such that the magnetic field therein created opposes and cancels the magnetic field created by the current flowing through the first inductor.
7. The apparatus of claim 1 where the first switch, the first inductor, the second switch and the second inductor are all employed for voltage conversion.

8. The apparatus of claim 1 where the magnetic material embedding the inductors is such that the inductors saturate when the current flowing through any inductor exceeds the peak current value that flows during normal voltage conversion.
9. The apparatus of claim 1 where the integrated voltage conversion and bypass control circuits received a bypass initiation analog or digital signal from the load device.
10. The apparatus of claim 1 where the integrated voltage conversion circuits receive an analog or digital signal from the load device for output voltage level programming.
11. The apparatus of claim 1 where electrical interconnection is accomplished between and by the invention device and the load device through electrical solder bumps on both semiconductor devices and interlayer package substrate interconnect through a common package substrate.
12. The apparatus of claim 1 where any signal communication is accomplished between and by the invention device and the load device through wireless RF, optical, or any non-contact signal communication methods through a common package substrate.
13. The apparatus of claim 1 where electrical interconnection between the invention device and the load device is accomplished through the thickness dimension of a common, thin, package substrate and through bulk or other material construction of very high thermal and electrical conductivity such as copper, carbon nanotubes, or alloys and composites that display similar or better thermal and electrical conductivity.
14. A 2-dimensional array of the invention devices of claim 1 integrated monolithically on the same semiconductor substrate, with necessary capacitance for the filter functions also integrated, employed as the mounting package substrate for the load device.
15. A method for transient suppression in high-bandwidth voltage regulation, comprising:

The integration of high-speed bypass pathways in parallel with voltage down-conversion pathways such as switching or linear regulators;

The activation of the bypass pathways in accordance with signals communicated by the load device requiring the transient charge flow;

And the connection of a plurality of such integrated devices, spatially distributed and in close physical proximity to the power grid of a load device, with input filter capacitors of sufficient value to supply the charge provided through the bypass pathways to the load without a detrimental degradation of the input voltage.
16. The method of claim 15 where a plurality of the integrated voltage conversion devices and associated output filter capacitors are placed directly opposite the regions of high transient current demand in the load power grid with a common package substrate between the load device and the distributed invention devices.

17. The method of claim 15 where the signal communicated by the load device indicating a transient load current demand comprises of an unusual, local, rate of change of, and absolute change of, the output node voltage.
18. The method of claim 15 where a transient, high current flow through the integrated voltage converter is facilitated by magnetic field cancellation or field saturation in the integrated inductors of the voltage converter.
19. Electronic systems comprised of various integrated and discrete electronic circuits and devices, electro-chemical, electro-thermal, electro-mechanical and electro-optic devices that employ the apparatus of claim 1 in any embodiment.
20. Electronic systems comprised of various integrated and discrete electronic circuits and devices, electro-chemical, electro-thermal, electro-mechanical and electro-optic devices that employ the method of claim 15 in any embodiment.